MUSKWA WOLF MANAGEMENT PROJECT OF NORTHEASTERN B.C. 1983-84 ANNUAL REPORT

Ministry of Environment
Fish and Wildlife Branch
Fort St. John, B.C.

Wildlife Working Report No. WR-8
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by

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SUMMARY

Wolf numbers in the Muskwa project area showed a continued increase over 1982-83. In total, wolves have increased four-fold in the Muskwa in the last six years. Very low snow accumulations combined with increased wolf numbers necessitated a phasing-in of wolf control with only 6700 square kilometres (2600 square miles) treated in 1983-84. There were 182, or 61%, of the wolves removed. Moose appear to have declined 15% this last year. Seventy-nine percent of the variation in late winter calf recruitment is explicable by wolf numbers. Cow elk appear to have declined 8% this last year. Eighty-two percent of the variation in late winter calf proportions is explicable by wolf numbers. Ewe mountain sheep appear to have declined 19% this last year. Ninety-one percent of the variation in late winter lamb proportions and 100% of the variation in second year survival are explicable by wolf numbers. Caribou, constituting less than 3% of the large mammal numbers in the Muskwa, appear to be doing well. It may be that wolves at this time do not seek out this species for food. Recovery of these ungulate populations may be expected from wolf management. It is recommended that wolf control be continued and conducted over the entire 19 000 km^2 area. Monitoring of ungulates and wolves should also be continued.

INTRODUCTION

The management of wolves in the Muskwa unit and elsewhere in northeastern B. C. (Figs. 1 and 2) has proceeded through several phases. During the second quarter of this century, the wolf was generally regarded as a major scourge of ungulate herds but little was done to modify the situation. Woodsmen travelling in the northeast of British Columbia at that time refer to a general paucity of game animals.

The beginning of the second half of this century saw wildlife agencies across the wolf's range commence the reduction - primarily with toxicants - of wolves. These programs were extensive and intensive in northern British Columbia including the Muskwa project area. The time extent of these programs varied; wolf reduction in northeastern British Columbia continued officially into the mid-1960's. However, substantial illegal wolf reduction effort continued into the early 1970's when increased federal restriction on the availability of toxicants and general loss of momentum appeared to have left illegal reduction at a low level. In contrast to the paucity of the second quarter of the century, numbers of game animals in northeastern B. C. during the 1960's and early 1970's were at high levels while wolf numbers were low.

Wolf population build-up followed the cessation of reduction effort. Surveys in northeastern B. C. showed wolves to average one per 148 sq km (57 sq mi) by the 1978-79 winter (B. C. Fish and Wildlife Branch 1984). Wolf numbers are now more than three times that level. During this period of wolf increase, ungulate herds have progressively deteriorated with isolated herds being eliminated and declines general and severe.

It was against this backdrop of increasing wolf numbers and decreasing ungulates that the Muskwa wolf management program was initiated (Elliott 1982, 1984). The program aimed to restore ungulate numbers and productivity in the Muskwa area through reduction in wolf numbers. The program area lies southwest of Fort Nelson, British Columbia and is described in Elliott (1984).

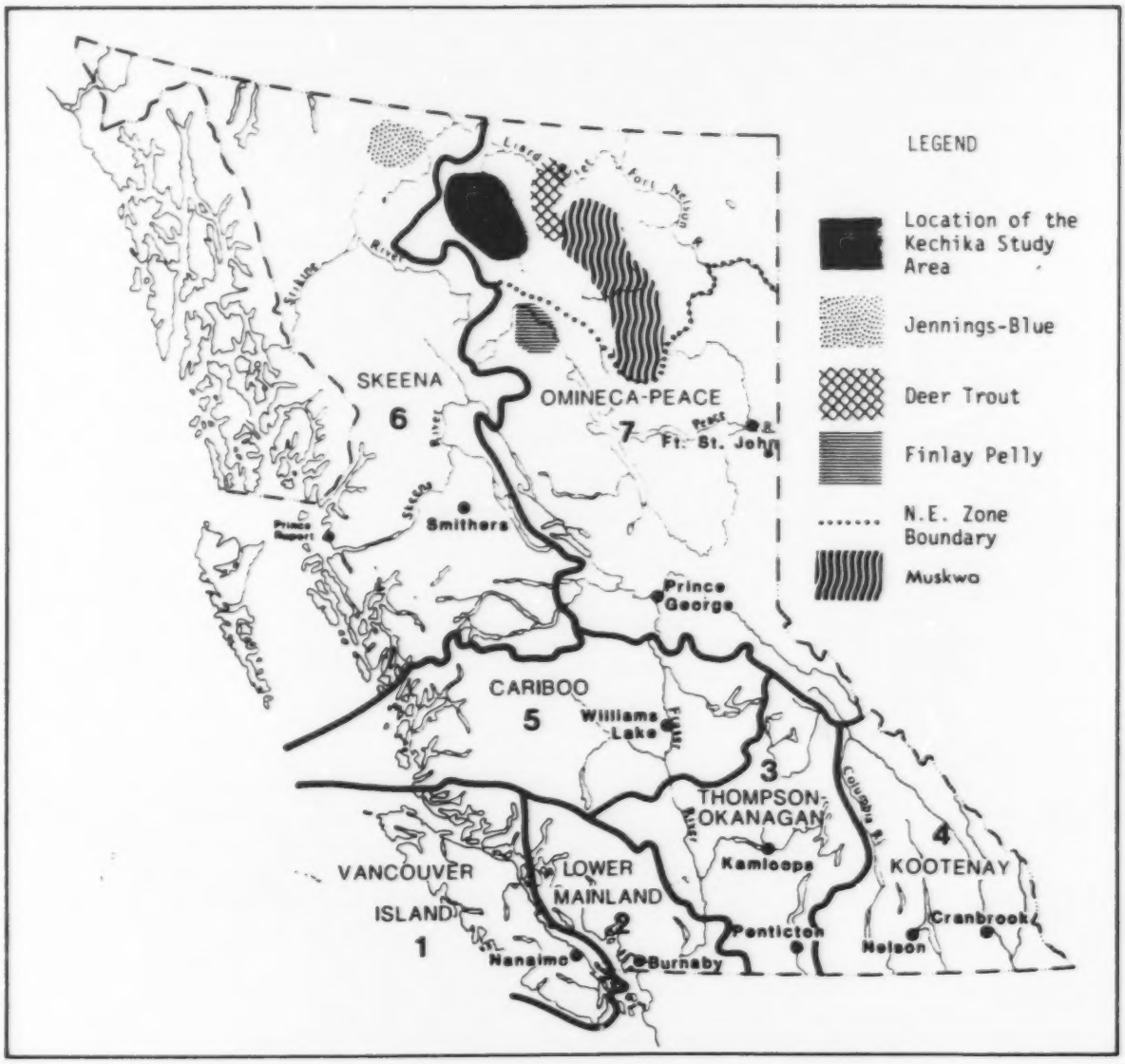

Figure 1. Map of British Columbia showing the location of areas referred to in the text and the zonal NE administration boundary.

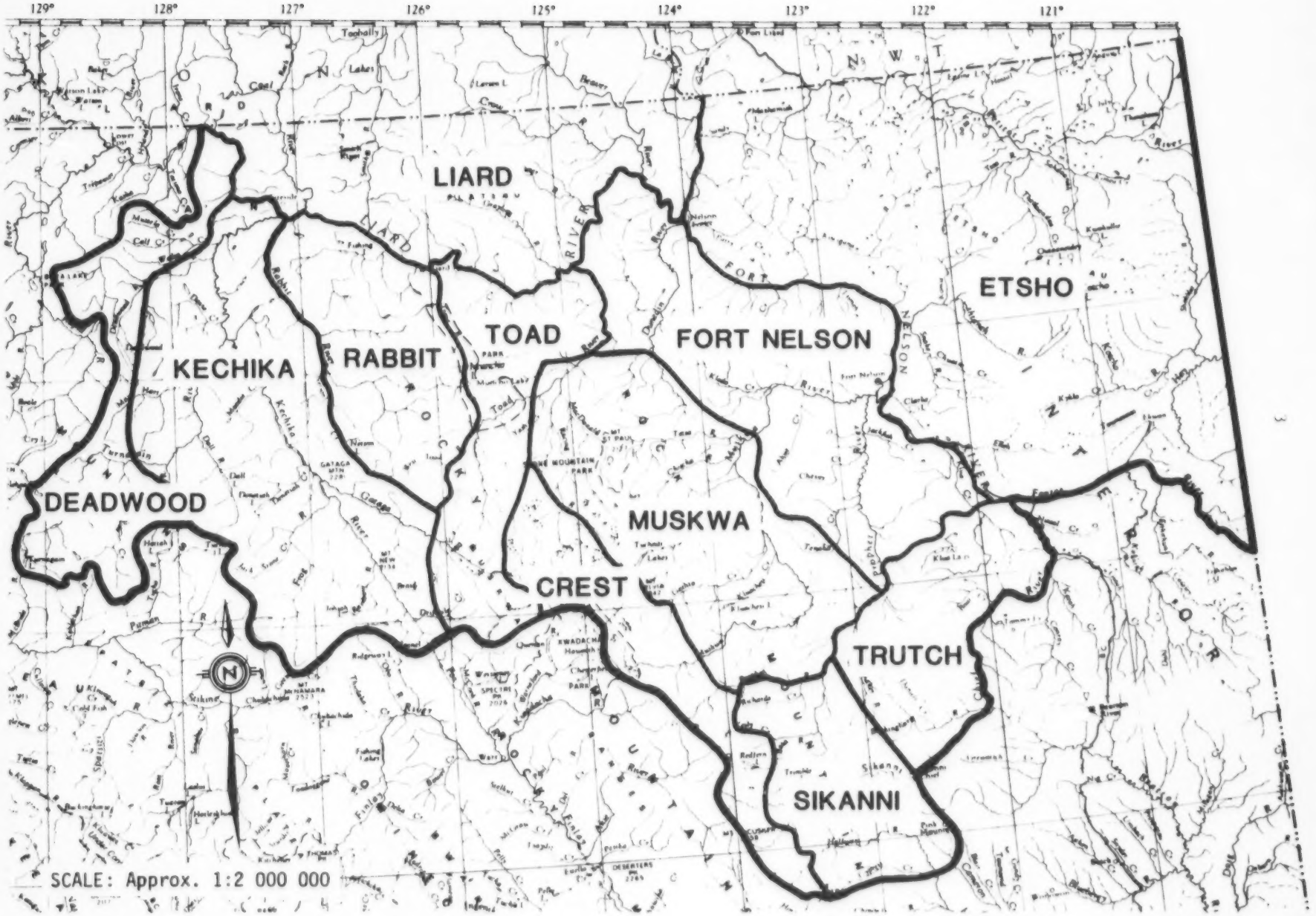

FIGURE 2: Subunits of the north east zone.

METHODS

GENERAL

Work during this reporting period was modified by the very low snowfall. The Fort Nelson water equivalent snow accumulation on March 1, at only 52% of average, was the lowest in the 18 years of recording (Water Management Branch 1984). Low snowpack increased the dispersion of the wildlife both in area and habitat type. In consequence, survey costs were substantially increased.

A second confounding factor was the substantial increase in wolves from when the program was first envisaged and even from 1982-83. This increase in wolves resulted in higher removal costs.

In response to these two factors, the following program aspects were deferred to 1984-85:

1) an area moose density estimate,
2) 80% wolf reduction,
3) full area wolf reduction, and
4) an area elk density estimate

Otherwise the program proceeded as planned with monitoring of all priority species, especially wolves, and significant wolf reduction in a portion of the Muskwa.

WOLF SURVEYS AND REDUCTION

Wolves were removed during January to March 1984 from a portion of the project area (2600 square miles/6700 square kilometres). In addition, wolves were inventoried over 4500 square miles/12 000 square kilometres of the area during that period.

Wolves were removed and inventoried utilizing a combination of aircraft. Inventory proceeded by flying likely wolf travel routes until fresh sign was encountered. The trail was then followed until either the wolves were spotted or the tracks separated sufficiently to enable a count. When necessary, track counts were confirmed by landing and examining the sign in detail from the ground.

Wolf removal was done by government personnel from a Bell 206 helicopter. Conventional shotguns loaded with SSG shot were used.

MOOSE AND ELK SURVEYS

A similar methodology was used for elk and moose surveys. In both cases, transects were flown for the purpose of determining the age and adult

sex ratios. Transects were uniformly spaced straight lines (modified where necessary for feasibility in rough topography) and predetermined on 1:250 000 scale maps. This pattern was assumed to be random relative to the animals and thus produce unbiased estimates. Surveys were undertaken in February and March.

Moose were classified as to calf, non-calf male, or non-calf female based upon shape, size, presence or absence of light vulval hair, head colouration, and antler scars. Elk were classified as to calf, yearling male, 2+ male, or non-calf female, based upon size, shape, and antler presence and configuration. Elk monitoring was confined to the winter range of the main herds found in the Muskwa, Kluachesi, Gathto, Tuchodi, and Chlotapecta drainages.

MOUNTAIN SHEEP SURVEYS

Mountain sheep were inventoried in February-March from a Bell 206 helicopter. Complete units were searched through all sheep habitat types and at all elevations and aspects by flying contours. Speed and closeness were varied so that the observers were placed optimally according to visibility.

Animals were classified as to lamb, yearling, 2+ female, 2-year male and 3+ male based upon size and horn characteristics. Because of the wider distribution of males, it was felt that the survey method for smaller units was biased against males; however, ratios of juveniles to ewes were believed unbiased.

CARIBOU

Caribou were surveyed in late October in the vicinity of the rutting benches between the Tuchodi and Tetsa Rivers. Bergerud (1978) refers to this as part of the Tuchodi River herd. These surveys were not intended to be complete counts but only unbiased samples. Animals were classified as to calf, non-calf cow, and non-calf bull. Sex differentiation was based on the presence or absence of the vulva.

DATA ANALYSIS

Sex and age composition data were expressed as ratios with females or totals as a denominator. Generally this takes the form of numbers per 100 females or of recruitment (the proportion of a population of a given age or older, for one or both sexes, which that given age group comprises).

Finite rates of population change (λ) were calculated from equation

$$(1) \quad \lambda = \frac{1-M}{1-R}$$

where R is the recruitment rate and M is the mortality rate for the animals of greater age than the recruitment age. $(\lambda-1)*100$ yields the percent population growth.

Statistical tests were standard. Proportional data were angularly transformed to improve normality; Chi-squares were not altered with Yates continuity modification.

RESULTS

WOLF SURVEY AND REDUCTION

Figure 3 and Table 1 summarize the 1983-84 late winter wolf numbers and wolf removal level. The total area surveyed was about 12 000 square kilometres (4650 square miles). This area contained some 463 wolves in 73 packs (groupings of two or more wolves) and 14 singles for an average 26 square kilometres per wolf (9.8 square miles per wolf)

Wolf densities for 1983-84 indicate a continued increase in wolves (Table 2). In 1982-83, 12 000 square kilometres (4650 square miles) of the Muskwa were surveyed for wolves and found to contain an estimated 346 wolves or one wolf per 35 square kilometres (13.4 square miles) (Elliott 1983a). In 1981-82, 7300 square kilometres (2810 square miles) of the Muskwa were surveyed for wolves and found to contain an estimated 112 wolves or one wolf per 65 square kilometres (25.1 square miles) (Elliott and Webster 1982). In 1977-78, 10 900 square kilometres (4200 square miles) of the Muskwa were surveyed for wolves and found to contain an estimated 115 wolves or one wolf per 95 square kilometres (36.5 square miles) (Bergerud 1978). Table 2 summarizes these statistics. It is apparent that wolves have increased steadily during the period of monitoring to the level where there are now approximately four times as many wolves as there were six years ago.

The 1983-84 restricted wolf reduction (treated) area was just over 6800 square kilometres (2600 square miles). This area contained 303 wolves in 51 packs and 11 singles. One hundred and eighty-two (60%) of these wolves were removed. Thirty-seven (18%) of the 209 wolves encountered in 1983-84 were black while the remaining one hundred seventy-two (82%) were gray. Twenty-one (48%) of forty-four wolves of known sex in 1983-84 were females. Fifty-six percent of the grays were female while twenty-five percent of the black wolves were female.

As in 1982-83 (Elliott 1983b), there was an area in the upper Crehan with a noticeably low wolf density. This is a popular location for fly-in fishing and it appears that wolf numbers continue to be reduced by various legal and illegal means by some of the fishermen. This area of about 360 square kilometres (140 square miles) contained in 1983-84 about one wolf per 90 square kilometres (35.0 square miles) in contrast to one per 25 square

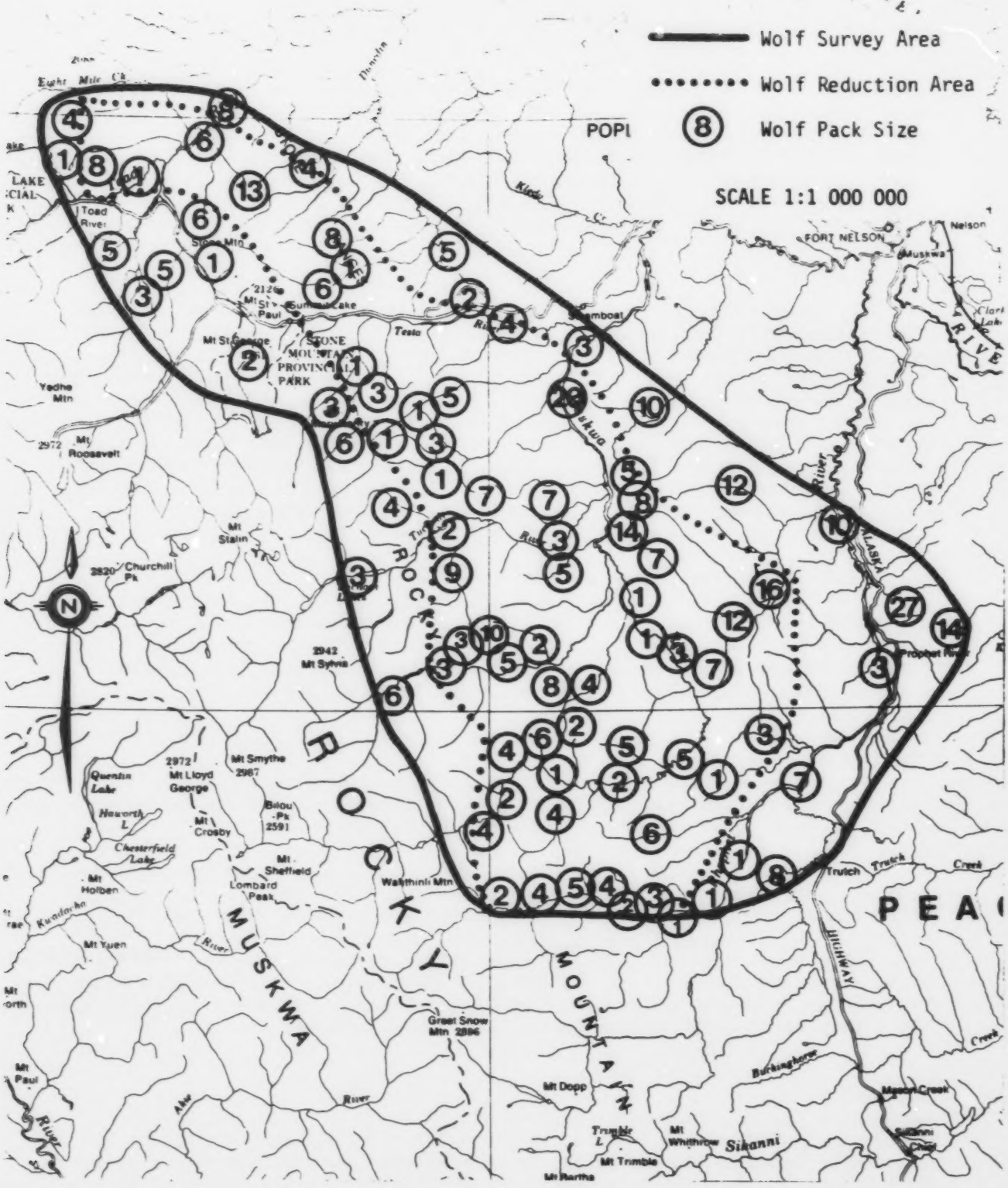

Fig. 5: Wolf Distribution - 1983-1984.

kilometres (9.6 square miles) elsewhere in the program area. In 1982-83, the Crehan had one wolf per 130 square kilometres (50 square miles) and the low wolf area extended further east which made it more consistent with elk annual ranges. This subunit is useful for providing some preprogram insight into the effect of low wolf numbers.

MOOSE SURVEY

The moose transect survey flights showed that for the majority of the Muskwa, the recruitment of moose was very low with only one cow (one year of age or older) in eleven still with a surviving calf (Table 3). In the Crehan portion where wolves were less common, one cow in four still had a surviving calf. Differing recruitments historically means that the 1983-84 difference is greater than that suggested by Table 3 (as 1 1/2 year cows did not produce calves) (Elliott 1983b). Table 4 incorporates information on the input of yearling animals from 1982-83 (Elliott 1983b) and examines only calves per producing female (2-years plus). It can be seen that the Crehan area has three times as many calves per cow as does the remaining high wolf density Muskwa where wolf densities are three times greater.

Table 5 examines some of the historical data for the Muskwa moose utilizing percent calves rather than calves per cow as the early data are available in the former only. The status of the moose herd has deteriorated substantially since 1977. Further, if the recruitments of Table 5 are compared to the inverse wolf densities of Table 2, a correlation is apparent (see Appendix A). Indeed, 79% of the variation between years in the recruitments (angularily transformed) is statistically explicable by the number of wolves. Equation 2 defines the best fit transformed linear dependence:

$$2)\quad \text{Percent moose calves} = 100*(\sin(10.88+(0.38*\text{square miles per wolf})))^2.$$

Gasaway et al.(1983) found adult moose mortality in the presence of moderate wolf numbers (1 per 64 square kilometres or 1 per 25 square miles) to be 20% annually, with wolf predation accounting for most moose deaths.

While it is apparent that the adult moose mortality rate will increase as wolf numbers increase, it follows that even based on a fixed 20% figure the calculable annual decline in moose has increased from about 4% to about 15%. This yields a 50% population decline every four years.

ELK SURVEY

Table 6 presents results of the elk transect survey flights. For the majority of the Muskwa, only one adult cow in seven still had a surviving calf by late winter. As already noted, the less dense wolf Crehan area did not correspond to the annual range of the winter elk herd; regardless the elk in that area tended to be less depleted than elsewhere.

Table 7 examines historical juvenile elk proportions for the Muskwa excluding Crehan and for the Crehan alone including the corresponding wolf densities. The herd status at high wolf numbers is substantially poorer than that at even moderate wolf numbers, with a strong correlation between juvenile proportions and the inverse wolf densities. Indeed, 82% of the variation in calf proportions (angularily transformed) is statistically explicable by the number of wolves (see Appendix A). Equation 3 defines the best fit transformed linear dependence:

3) elk calves/100 adult cows = $100*(\sin(19.88+(0.20*\text{square miles per wolf})))^2$.

In Jasper, Carbyn (1974) found adult female elk annual mortality with moderate wolf densities to be 14%. From Table 6, it can be calculated (assuming a standard 50:50 sex ratio) that late winter female calf recruitment for the Muskwa is 6.2% (100* ((97/2)/(689+90/2)+(97/2)))). Assuming that adult mortality for the high wolf Muskwa is as low as that of Jasper, it can be calculated from equation 2 that the cow elk herd declined this last year by a further 8%.

MOUNTAIN SHEEP SURVEY

Table 8 presents results of the mountain sheep survey flight. Table 9 examines historical juvenile-ewe proportions for the Muskwa including corresponding wolf densities. The first and second year survival (as indicated by lamb-to-ewe and yearling-to-ewe (year x) to lamb to ewe (year x-1 ratios) has progressively deteriorated and is strongly negatively correlated with the inverse wolf densities. Indeed, 90% of the year-to-year variation in lamb proportions (angularily transformed) and 100% of the year-to-year variation in yearling to previous year lamb proportions is statistically explicable by the number of wolves. Equations 4 and 5 define the best fit transformed linear dependence:

4) lambs/100 adult ewes=$100*(\sin(23.55+(0.57*\text{square miles per wolf})))^2$.

5) yearlings/100 lambs the previous year=$100*(\sin((2.14*\text{square miles per wolf})-1.78))^2$.

Hoefs and Cowan (1979) found an annual adult thinhorn mountain sheep ewe mortality for Kluane of 20%. This rate was partially dependent upon predator numbers. It can be calculated (assuming a 50:50 sex ratio) from Table 8 that late winter female yearling mountain sheep recruitment for the Muskwa was 1.7% (100* ((12/2)/(345+12/2)))). Assuming adult mortality to equal that of Kluane, a net ewe decline in excess of 19% can be expected for 1984 versus 1983.

CARIBOU SURVEY

Table 10 presents results of the caribou survey flight. It is apparent that caribou are rather an anomaly in the Muskwa at this time in that they show a good recruitment. Bergerud (1978) found similar recruitment (16%) during his survey. It may be that caribou are such a small portion (less than 3%) of the available large mammal prey that wolves do not have a 'search image' for this species at this time (Tinbergen 1960).

THE WEATHER EFFECT

Elliott (1982) and Elliott et al.(1984) speculated on the possible role of winter severity in affecting present and subsequent recruitment. Table 11 presents April 1 water equivalent snowpacks (a measure of snowfall and coldness) for Fort Nelson. It can be seen that while juvenile survival of moose, elk, and mountain sheep has been generally declining each year (Tables 5, 7, and 9), the winters have been generally becoming milder.

THE PROGRAM FOR 1984-85

The program will proceed as designed with modifications as necessary to facilitate logistic considerations such as weather. Specifically,

1) Moose density will be estimated in a portion of the Muskwa, utilizing stratified random aerial sampling.

2) Recruitment will be estimated for much of the Muskwa utilizing uniformly spaced aerial transects,

3) Elk density and recruitment will be estimated for the main elk herd utilizing stratified random aerial sampling.

4) Wolf numbers will be estimated for much of the Muskwa utilizing aerial travel route searching.

5) Wolves will be reduced by 80% of 1983-84 numbers over the program area.

CONCLUSIONS

Preliminary data suggest that an increase in wolf numbers corresponds with a decline in moose, elk, and mountain sheep numbers. In so far as predation by wolves limits moose, elk, and mountain sheep, then recovery of those declining populations can be achieved through wolf management.

An increase in game species and hunting use would provide economic benefits to the Province and the local economy. The project should continue for the planned three-year period with increased effort to monitor the effects of wolf control on the ungulate population.

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Table 1. Wolf status in the Muskwa program area, February-March 1984.

	area (sq mi)	area (sq km)	number of wolf packs[1]	number of wolves	sq mi per pack[1]	sq mi per wolf	wolves per pack[1]
total area pre-reduction	4549	11782	73	463	62.3	9.8	6.2
untreated area	1933	5006	22	160	87.9	12.1	7.1
treated area prereduction	2616	6775	51	303	51.3	8.6	5.7
treated area postreduction	2616	6775	--	121	----	21.6	---

[1] excludes single wolves

Table 2. Recent historical wolf estimates in the Muskwa area, late winter aerial surveys.

Year	Sq Mi Surveyed	Sq Km Surveyed	Number of Wolves Present	Sq Mi /Wolf	Sq Km /wolf
1977-78	4200	10800	115	36.5	94
1981-82	2810	7300	112	25.1	65
1982-83	4650	12000	346	13.4	35
1983-84	4549	12000	463	9.8	26

Table 3. Moose proportions seen during Muskwa transect flights, February-March 1984.

Area	Number Seen[1]			
	Non-calf bulls	Non-calf cows	Calves	Total
Muskwa, excluding Crehan	103(48.8)	211	19(9.0)	333
Crehan	30(47.6)	63	15(23.8)	108

Chi square (calves to cows) = 7.14 (0.01>P. of similarity>0.005)

[1] number per 100 cows in parentheses.

Table 4. Moose calves per two year and older cows, February-March 1984.

	Cows(2+)	Yearling Cows	Calves
Muskwa, excluding Crehan	100	6.2	9.6
Crehan	100	19.9	28.5

Table 5. Recent historical moose recruitments in the Muskwa area, late winter aerial surveys.

Year	Percent Moose Calves	Sample Size	Source
1977-78	15.2	211	Bergerud, 1978
1981-82	16.5	328	Elliott & Webster, 1982
1982-83	6.9	303	Elliott, 1983b
1983-84	5.7	333	this document

Table 6. Elk proportions seen during Muskwa transect flights, February-March 1984.

	Number Seen[1]				
	Bulls(2+)	Cows(2+)	Yearlings[2]	Calves	Total
Muskwa, excluding Crehan	168	689	90(13.1)	97(14.1)	1044
Crehan	27	90	20(22.2)	16(17.8)	153

G statistic (cows, calves, yearlings *area)=3.8 (0.25>P. of similarity>0.10)

[1] number per 100 cows in parentheses.

[2] calculated as 2 times the number of spike bulls

Table 7. Recent historical elk juvenile to adult cow proportions in the Muskwa/Crehan area, late winter surveys, plus reciprocal wolf densities.

Year	Area	Yearlings /100 cows (2+)	Calves /100 cows (2+)	sq mi /wolf	Source
1981-82	Muskwa	23.9	20.9	25.1	Elliott and Webster (1982)
1982-83	Muskwa, excluding Crehan	10.0	13.8	13.4	Elliott(1983a)
1982-83	Crehan	34.0	26.0	50.0	Elliott(1983a)
1983-84	Muskwa, excluding Crehan	13.1	14.1	9.8	This document
1983-84	Crehan	22.0	17.8	35.0	This document

Table 8. Ewe-juvenile mountain sheep proportions seen during Muskwa surveys, February-March, 1984.

	Category			
	Ewe(2+)	Lamb	Yearling	Total
Number	345	73	12	430
per 100 adult ewes	100	21.2	3.5	

Table 9. Recent historical mountain sheep juvenile proportions plus reciprocal wolf densities for the Muskwa, late winter surveys

Year	Lambs /100 ewes (2+)	Yearlings /100 ewes (2+)	Yearling/100 lambs the previous year	sq mi wolf	sq km wolf
1980-81	40.2	27.3	----	28.0*	72
1981-82	36.8	25.0	62.2	25.1	65
1982-83	30.2	7.0	19.0	13.4	35
1983-84	21.2	3.5	11.6	9.8	25

* interpolated from the 1977-78 and 1981-82 known densities

Table 10. Caribou proportions seen during Muskwa survey flight, October, 1983.

	Category			
	non-calf bull	non-calf cow	calf	total
number	34	64	25	123
% of total	28	52	20	-
# per 100 cows	53.1	100	39.0	

Table 11. Winter severity indices for Fort Nelson.

Year	April 1 H_2O equivalent snowpack	Severity Index[1]
1977-78	132	129
1978-79	140	137
1979-80	120	118
1980-81	62	61
1981-82	197	193
1982-83	78	76
1983-84	44	43
18 year average	102	---

[1] snowpack as a percent of long-term average

Appendix A. Arcsin regressions, juvenile ungulates versus square miles per wolf, by year.

1. Moose calves (February - March)
2. Elk calves (February - March)
3. Mountain sheep lambs (February - March)
4. Mountain sheep yearlings (February - March)

1. Moose calves

Year	Square miles/wolf (X Value)	% moose calves (Y Value)	Arcsin Y
1977-78	36.5	15.2	22.95
1981-82	25.1	16.5	23.97
1982-83	13.4	6.9	15.23
1983-84	9.8	5.7	13.81

Arcsin Y = 10.88 (.38 * X)

HO: B=0

Source of variation	Sum of squares	DF	Mean square
Total	81.37	3	
Regress	64.36	1	64.36
Resid	18.00	2	8.50

F = 7.57
DF = 1 and 2
r^2 = .79
r = .89
Sy.x = 2.92

2. Elk calves

Year	Square miles/wolf (X Value)	calves/100 cows (Y Value)	Arcsin Y
1981-82[1]	25.1	20.9	27.2
1982-83[1]	13.4	13.8	21.81
1983-84[1]	9.8	14.1	22.06
1982-83[2]	50	26.0	30.66
1983-84[2]	35	17.8	24.95

Arcsin Y = 19.88 (.20 * X)

HO: B=0

Source of variation	Sum of squares	DF	Mean squares
Total	55.17	4	
Regress	45.03	1	45.03
Resid	10.14	3	3.38

F = 13.33
DF = 1 and 3
r^2 = .82
r = .90
Sy.x = 1.84

[1] Muskwa, excluding Crehan
[2] Crehan

3. Mountain sheep lambs

Year	Square miles/wolf (X Value)	lambs /100 cows (Y Value)	Arcsin Y
1980-81	28	40.2	39.35
1981-82	25.1	36.8	37.35
1982-83	13.4	30.2	33.34
1983-84	9.8	21.2	27.42

Arcsin Y = 23.55 (.57 *X)

HO: B=0

Source of variation	Sum of squares	DF	Mean square
Total	83.08	3	
Regress	75.24	1	75.24
Resid	7.84	2	3.92

F = 19.18
DF = 1 and 2
r^2 = .91
r = .95
Sy.x = 1.98

4. Mountain sheep yearlings (year t) to lambs (year t-1)

Year	Square miles/wolf (X Value)	yrlgs ratio (t)/ lamb ratio (t-1) (Y Value)	Arcsin Y
1981-82	25.1	62.2	52.06
1982-83	13.4	19	25.84
1983-84	9.8	11.6	19.91

Arcsin Y = 1.78 (2.14 * X)

HO: B=0

Source of variation	Sum of squares	DF	Mean square
Total	585.38	2	
Regress	583.75	1	583.75
Resid	1.63	1	1.63

F = 358.09
DF = 1 and 1
r^2 = .997
r = .999
Sy.x = 1.28

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Wildlife working reports should not be cited because of the preliminary nature of the data contained within.

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